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## SPECIAL ARTICLES

RECENT DISCOVERIES IN THE HISTORY OF THE  
COMMON EEL<sup>1</sup>

No fish is more generally and widely known than the common eel and none has been involved in more mystery. The absence of developed sexual organs has given rise to many strange hypotheses and fables. The true history has been made known only within the last two years. The most satisfactory of recent observations have been made by Dr. Johannes Schmidt, Dr. C. G. J. Petersen and K. J. Gemzøe, of Denmark.

It has long been known that the eel descends into the sea to spawn, but the exact destination has been unknown. For information respecting this, we are indebted to Dr. Schmidt, who has in great detail recorded the results of two expeditions to ascertain the facts.<sup>2</sup>

None of the eels found in the ocean had fully matured eggs, and the ovaries were only moderately developed. Indeed, according to Schmidt, as recently as 1906, "no one had yet succeeded in finding [in the males] spermatozoa, nor in the female eggs which were larger than  $\frac{1}{3}$  mm. in diameter, much smaller as a rule, and never clear as the eggs of other species are known to become before spawning. No one had yet described the eggs of the eel in a condition near to spawning or even approximately mature."

The period between the descent into the sea and the appearance of larvæ near the surface has yet to be known, but larvæ have been found by Dr. Schmidt in regions where the depth of the water was about 1,000 meters, and he has concluded that "the eel spawns out in places of at least nearly 1,000 meters depth." In such places, in May and June (especially about the middle of June), larval eels about three inches long are to be found. They are then mostly in the typical leptocephalus stage, diaphanous and without pig-

ment cells, having very compressed and high or ribbon-like bodies, anus far behind, very small heads, large eyes, pointed snouts and full sets of slender teeth directed forwards in the jaws. During the succeeding months, a transformation takes place, in some early, in others delayed.

The body becomes reduced in height, especially backwards, and expands sideways, "the hindmost portion of the gut disappears," and the anus gradually advances forwards, the head at last is less disproportionate and the eyes relatively small, and, above all, the slender spike-like teeth, so characteristic of the typical leptocephaline stage, are dropped. By September and the later autumn the leptocephali of summer have mostly undergone their transformation into a later leptocephalus stage.

All this time the larval eels remain in the ocean not very far below the surface, quite near, it may be, at night, sinking downwards more or less during daylight. Late in the season they gradually approach to the shores, continuing meanwhile their change from leptocephalines into true eels. The time of their entrance into the mouths of rivers depends to some extent on the distance of those mouths from the line of about 1,000 meters or over 500 fathoms. In France, as well as Ireland and England, for instance, they may begin to enter streams as early as January or February, while in Denmark and Norway, none enter earlier than March, and the chief incursion is during April.

During the entire time from the appearance of the leptocephalines near the surface of the ocean to their entry into the rivers, the hyaline condition of the little fishes continues. The body is so diaphanous that only by the closest attention can it be detected, and then chiefly because the eyes are prominent and distinctly colored. Indeed, the first thought on seeing a school of leptocephalines may be wonder that so many eyes are floating about.

The diaphanous condition undoubtedly is an efficient protection against many of the dangers the larval eels encounter. Nevertheless it is only a partial protection. The course of the young fishes riverward is beset with dangers, and these increase as the coast is ap-

<sup>1</sup> Presented to the Biological Society of Washington, October 17, 1908.

<sup>2</sup> Schmidt (Johs.), "Contributions to the Life-history of the Eel (*Anguilla vulgaris* Flem.), Rap. et P. V. Conseil Int. Expl. Mer., V., p. 137-274, pl. 7-13, 1906.

proached. Fishes of the high seas intercept many; still more become the food of the large fishes of the banks and coasts, and of such is especially the cod. That voracious fish rises to them and inflicts great slaughter.

The later changes of the larva into a miniature eel are especially remarkable. Instead of growing larger, the little fish grows smaller and smaller, so that an individual that had been over three inches long may shrink to a length of not more than two inches, and the ribbon-like form may dwindle into a thread-like body. Increase is concentrated into growth sideways and with this the diaphanous character is lost. Meanwhile, "pigment is developed, first on the end of the tail, later on the neck, and lastly over the greater part of the dorsal and lateral aspects."

The gradual changes thus indicated have been segregated by Schmidt into six groups or stages, based on specimens obtained by him.

During all the gradual metamorphosis so illustrated, and which takes a full year for completing according to Schmidt, "the larvæ do not take any nourishment." This abstinence from food has been determined by Grassi and Calandruccio and A. C. Johnsen, as well as Schmidt. Johnsen "investigated over thirty specimens from the North Sea and the Danish waters and found the alimentary canal empty in all of them."

The young eels or elvers that in spring commence their ascent of the streams, which become their homes, must be the offspring of old eels which left the streams not during the last autumn, but the one preceding that; consequently, about a year and a half must intervene between the time a parent eel begins a journey to fulfill her procreative duties and that when the offspring is ready to take up its life under similar conditions. This is a history very different from any ordinary fish's, and so far as known unique outside of its genus.

The growth of the eel in fresh water has this year, 1908, been elucidated by Mr. Gemzøe from examination of the scales.<sup>3</sup>

<sup>3</sup> Gemzøe (K. J.), "Age and Rate of Growth of the Eel," Rep. Dan. Biol. St., XIV., p. 10-39, tab. 14, 1908.

The young eel lives and grows for some time without scales. Indeed, "it has lived in [Danish] waters two years, reckoned from the time it arrives as *montée* (glass-eel, elver) in its early migration"; it is then about 7 inches (18 cm.) long. The scales grow only during the warm months (June to September) and the intervals of arrest of growth differentiate the growth of the respective years. The early years are passed with a yellowish belly. "The females become silver later, scarcely before they are six and a half years old, the majority not before they are seven and a half years, and many indeed only become silver when they have been eight and a half years" in fresh water. If to these figures we now add a year and a half for the time the eggs are being matured and the *leptocephalus* stage developed, it appears that an eel must be from eight to ten years old before it assumes the livery of maturity and descends into the ocean to reproduce its kind.

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#### THE ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

THE ninth meeting was held at the Hotel Victory, Put-in-Bay, Ohio, August 25-28, 1908. In addition to the reading of papers, the society appointed two committees: one on luminous meteors, consisting of Messrs. Abbe, Elkin and Peck; the other on comets, consisting of Messrs. Comstock, Pickering, Barnard and Perrine. Officers were elected as follows:

*President*—E. C. Pickering.

*First Vice-president*—G. C. Comstock.

*Second Vice-president*—W. W. Campbell.

*Secretary*—W. J. Hussey.

*Treasurer*—C. L. Doolittle.

*Councilors for 1908-10*—W. J. Humphreys and Frank Schlesinger.

We give below a list of papers presented at the society's sessions, together with brief abstracts:

*Formulas used for the Reduction of Satellite Observations*: ASAPH HALL.

*Doolittle's Measures of the Hough Double Stars*: G. W. HOUGH. (Published in *Popular Astronomy*.)

*The Standard Clock at the U. S. Naval Observatory*: W. S. EICHELBERGER.